Arcsecond Pointing Stability on a CubeSat Platform, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

In this proposal, Tyvak Nano-Satellite Systems LLC (Tyvak) will improve the state-of-the-art in low-jitter CubeSat platforms to one arc-second pointing stability. This platform will address the increasing attitude control performance requirements of CubeSats to enable commercial and scientific missions previously restricted to larger and more expensive satellite platforms. Reducing jitter in attitude determination and control systems (ADCS) CubeSat platforms has typically been an after-thought. Miniaturizing large satellite ADCS to CubeSat size has resulted in relatively poor attitude stability due to inexpensive reaction wheels and high noise IMU?s. In the past five years, the CubeSat industry has seen a huge increase in customers with miniaturized payloads seeking high capability platforms. Arcsecond attitude stability is an enabling technology for many optical missions, including optical communication, space based optical inspection, and exoplanet imaging.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The interest in CubeSats has grown exponentially over the last decade. From scientists to the U.S. war fighter, the aerospace community has seen the tangible benefits of using CubeSats to satisfy key roles in their experiments and operational missions. NASA has played a significant role in fostering the growth of the CubeSat community. Exoplanet imaging is an application that requires extremely good pointing stability. NASA?s Kepler mission, launched in March 2009, is currently surveying a large section space in search of exoplanets. Follow-up measurements on specific targets identified by Kepler would be a great fit for CubeSat exoplanet imagers, as very long measurements could be taken at relatively low cost. The number of CubeSat exoplanet imagers would easily scale, allowing follow-up measurements of hundreds of potential exoplanets. Beyond

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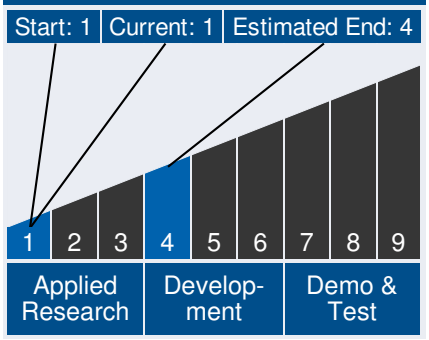
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

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imaging applications, the NASA Ames LADEE mission utilized laser communication to provide a high bandwidth long distance communication link. Laser communication was demonstrated from the moon with a beamwidth of 3 arc-seconds, requiring tight pointing stability from the ADCS. The technology developed in this SBIR could allow high bandwidth laser communication links without a separate pointing control stage, freeing up limited CubeSat payload space.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Arcsecond level jitter performance is important for low-light optical imaging applications, particularly satellite inspection missions. These missions have traditionally been restricted to government agencies, though commercial satellite inspection in the GEO belt would be useful for satellite operators to diagnose failures at a safe distance. Although most Earth imaging occurs at very short exposure windows (<1ms), increased attitude stability in a standard platform would improve the ground resolution/price ratio for these missions. There is likely commercial interest in a star tracker that can operate as a rate sensor. The rate sensor can be used as a backup to an IMU in control systems, or even as the primary sensor for precision pointing. Since the rate sensor will be relatively high bandwidth, the rate sensor technology could increase the control loop bandwidth, providing better pointing accuracy and stability at low altitudes or in the presence of other disturbance torques.

Management Team *(cont.)*

Principal Investigator:
- Solomon Westerman

Technology Areas

Primary Technology Area:
Communications, Navigation, and Orbital Debris Tracking and Characterization Systems (TA 5)
└ Position, Navigation, and Timing (TA 5.4)
  └ Sensors and Vision Processing Systems (TA 5.4.3)

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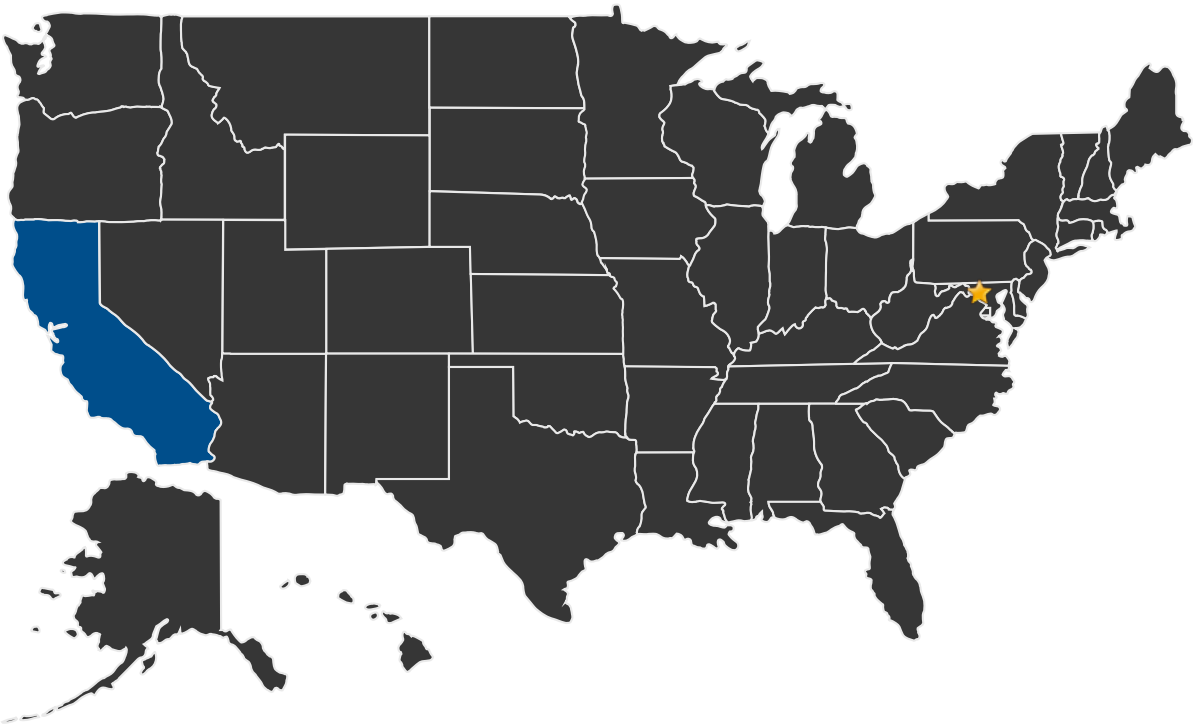
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Goddard Space Flight Center

Other Organizations Performing Work:

- Tyvak Nano-Satellite System Inc (Irvine, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23320)

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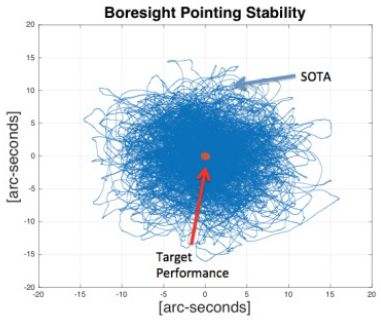
IMAGE GALLERY



Arcsecond Pointing Stability on a CubeSat Platform, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

Arcsecond Pointing Stability on a CubeSat Platform, Phase I

Potential Applications

The interest in CubeSats has grown exponentially over the last decade. From scientists to the U.S. war fighter, the aerospace community has seen the tangible benefits of using CubeSats to satisfy key roles in their experiments and operational missions. NASA has played a significant role in fostering the growth of the CubeSat community. Exoplanet imaging is an application that requires extremely good pointing stability. NASA?s Kepler mission, launched in March 2009, is currently surveying a large section space in search of exoplanets. Follow-up measurements on specific targets identified by Kepler would be a great fit for CubeSat exoplanet imagers, as very long measurements could be taken at relatively low cost. The number of CubeSat exoplanet imagers would easily scale, allowing follow-up measurements of hundreds of potential exoplanets. Beyond imaging applications, the NASA Ames LADEE mission utilized laser communication to provide a high bandwidth long distance communication link. Laser communication was demonstrated from the moon with a beamwidth of 3 arc-seconds, requiring tight pointing stability from the ADCS. The technology developed in this SBIR could allow high bandwidth laser communication links without a separate pointing control stage, freeing up limited CubeSat payload space.